HOW MUCH WATER PASSES THROUGH EACH OF THE SOUTHERN INDONESIAN PASSAGES?

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LONG-TERM GOALS

The goal of this project is to obtain a more thorough understanding of the dynamics of the Indonesian Throughflow. We plan to establish new flow rate laws for currents forced through a dense arrangement of islands.

OBJECTIVES

We are conducting analytical and numerical investigations of the Indonesian throughflow and plan to make comparisons of the results with data presently being collected as part of Arlindo II. ["Arlindo II" is a cooperative project of the U.S. and Indonesia. The abbreviation ARLINDO originates in Malay and stands for: avarus (sea), lintas (flow) and Indonesian.] In particular, we examine (1) the amount of water that can be forced through a single "intermediate" gap (i.e., a gap that is neither broad nor narrow), and (2) the distribution of such flows through a "porous" wall containing a number of "intermediate" gaps. The interest is in the application of the above calculations to warm (and fresh) Pacific waters exiting from the Indonesian Seas through the Lombok Strait, the Alor Strait and the Timor Passage.

WORK COMPLETED

Analysis of the Throughflow's origin, and an analysis of the maximum rate of flow that a broad gap on a beta-plane can handle.

RESULTS

Research has resulted in the preparation and publication of several papers, listed below in the order that they were completed. Most have not been supported solely by ONR but also by NSF and NASA. The papers that are most closely related to the Throughflow study are #6 and #9.

First, we looked at the separation of western boundary currents, with particular application to the collision and separation of the Brazil and Malvinas Currents (papers 1 and 2). We determined that the observed migrations of the separation latitude may be caused by seasonal changes of the Malvinas Current transport. Next, we examined the formation of eddies when a density current

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flows along and around an irregular coast boundary (papers 3-5). The next paper (#6) showed that the Indonesian Throughflow plays a crucial role in the dynamics of the entire western Pacific. In paper #7 we examined the question of how deep ocean eddies can cross the equator and, with analytical and numerical models, determined that the geometry of the channel and the presence of the equator determine how the fluid will be partitioned among the two hemispheres. Using a simple analytical model to compute the meridional warm water flux in the Atlantic (paper 38), we illustrated that a significant part of the water in the Global Conveyor Belt that ultimately sinks in the north Atlantic is of intermediate (cold) and not surface (warm) origin. The "separation formula," a new method for computing the inter-hemispheric meridional transport, was applied to the Pacific Ocean (paper #9). The model suggested that the observed Pacific to Indian throughflow is a measure of the upwelling (or cooling) in the Pacific. Next, we applied a previously developed model (Nof and Pichevin, 1996, *Journal of Physical Oceanography*, v. 26, 2344-2358) describing the intimate relationship between retroflecting currents and the production of rings to the Agulhas Current (paper #10). We showed that the generation of rings from a retroflecting current in inevitable, and that there is no obvious relationship between the presence of so-called "Natal Pulses" and the production of rings. We then proposed a new theory for the generation of the Tsugaru and Alboran gyres (paper #11). The generation of these gyres is caused by the (otherwise imbalanced) flow force of the long-shore current downstream regardless of the initial current vorticity. Last, paper #12 examined the exchange of water between hemispheres by looking at the behavior of continuous (double frontal) abyssal currents situated on the bottom of a meridional channel. We determined that the inter-hemispheric exchange is primarily an inertial process that depends mainly on the channel geometry.

IMPACT/APPLICATIONS

The results of our calculations for the single intermediate gap problem are formulas relating the transport through the gap to its width, depth and the sea-level difference between the connecting basins. Similarly, the multiple intermediate gap problem will yield formulas relating the relative transport that passes through each of the passages (i.e., the percentage of the total transport that a given passage can handle) to the size of each gap, the size and location of the adjacent gaps and the sea-level difference between the connecting basins. This useful information will then be compared to the actual transport calculated from shallow pressure gauges which will be available by the time that the theory is completed. The combination of these two independent means of computation will enable us to better understand the dynamics of the throughflow. Without this combination it is doubtful that a thorough understanding can be achieved.

TRANSITIONS

We showed that, under some conditions, the geometry of the coast and not instability forces the formation of eddies. We also showed that, when this is the case, the size of the eddies is greater than that produced by instability.

RELATED PROJECTS

This project is closely related to the NSF project # OCE-9503816 entitled “Flows through multiple gaps with applications to the Indonesian Throughflow” but supports the study of the western rather than the eastern passages. Also, the NASA project # NAGW-4883 entitled “Studies of Variable Climate Processes” examines the exchange of surface water between the Indian and South Atlantic Oceans.